Ministry of Higher Education
and Scientific Research
Misan university
College of Dentistry
Graduation Project

وزارة التعليم العالي
والبحــث العلمي
جامعة ميسان
كلية طب الأسنان
بحث تخرج

Project Name

Odontogenic maxillary sinusitis:- comprehensive overview

Written by

Ftama Falah ,

zhraa Rabeaa,

AdeanHassn

and Fatama Hedar

Supervisor:-

Dr. Afrah Adel

ASS-Lect, M.Sc.

2022-2023

Our study trip has reached its end after exhaustion and hardship

And we are concluding the research of our graduation with all vigor and vigor .We are grateful to everyone who has been credited with our journey ,and help us ,even with ease. Parents, family , friends , and esteemed teachers. We present to you a study of our graduation.. . And do not forget the greatest credit to our research supervisor (Dr. Afrah Adil Hassan), by providing us with valuable and useful information. Thank you very much doctor....


الله
نور السموات والأرض
مثل نوره كمشكاة فيها مصباح المصباح في زجاجة الزجاجة كأنها كوكب دري
يوقد من شجرة مباركة زيتونة لا شرقية ولا غربية كاد زيتها
يضيء ولو لم تمسسه نار
نور على نور
يهدي الله لنوره من يشاء ويضرب الله الأمثال للناس والله بكل شيء عليم

Table of Contents

List of acronyms

The acronym	full name
OMS	odontogenic maxillary sinusitis
OMC	osteomeatal complex
ARS	Acute rhinosinusitis
AFRS	Acute fungal rhinosinusitis
ESS	Endoscopic sinus surgery
OAF	oroantral fistula
CRS	Chronic rhinosinusitis
CLP	Caldwell Luc procedure
FESS	Functional Endoscopic Sinus Surgery
H. influenza	Haemophilus influenza
P. aeruginosa	Pseudomonas aeruginosa
SM	Schneiderian membrane
URI	Upper respiratory tract infection

Abstract

Maxillary sinusitis of odontogenic origin, also known as maxillary sinusitis of dental origin or odontogenic maxillary sinusitis (OMS), is a common disease in dental, otorhinolaryngologic, allergic, general, and maxillofacial contexts. Despite being a well-known disease entity, many cases are referred to otorhinolaryngologists by both doctors and dentists. Thus, early detection and initial diagnosis often fail to detect its odontogenic origin.

Introduction

Odontogenic sinusitis is a well-recognized condition and accounts for approximately 10% to 12% of cases of maxillary sinusitis. An odontogenic source should be considered in individuals with symptoms of maxillary sinusitis with a history of odontogenic infection, dentoalveolar surgery, periodontal surgery, or in those resistant to conventional sinusitis therapy. Diagnosis usually requires a thorough dental and clinical evaluation including appropriate radiographs. The most common causes of odontogenic sinusitis include dental abscesses and periodontal disease that had perforated the Schneidarian membrane, irritation and secondary infection caused by intra-antral foreign bodies, and sinus perforations during tooth extraction. Surgical and dental treatment of the odontogenic pathological conditions combined with medical therapy is indicated. When present, an odontogenic foreign body should be surgical removed. Surgical management of oroantral communication is indicated to reduce the likelihood of causing chronic sinus disease. The management of odontogenic sinusitis includes a 3- to 4-week course of antimicrobials effective against the oral flora pathogens.[Brook, I. (2006)]

Review

2. DEVELOPMENT OF SINUSES

Paranasal sinuses' development is heralded by the appearance of a series of folds on the lateral nasal wall at approximately the eighth week of gestation, known as the ethmoturbinals. Six to seven folds emerge initially, but eventually, only three to four persist through regression and fusion.

First ethmoturbinal: they are rudimentary and incomplete in humans. The ascending portion forms the agger nasi descending portion forms the uncinate process. .[Brook, I. (2006)]

Second ethmoturbinal : it forms the middle turbinate.

Third ethmoturbinal: it forms the superior turbinate.

Fourth and fifth ethmoturbinals: they fuse to form the supreme turbinate.

As development progresses, furrows form between these ethmoturbinals, which establishes rudimentary meati and recesses. .[Brook, I. (2006)]

2.1.The frontal sinus

originates from the anterior pneumatization of the frontal recess into the frontal bone. The frontal sinus does not appear until the age of 5 to 6 years old.

2.2.The sphenoid sinus

develops during the third month of gestation. During this time, the nasal mucosa invaginates into the posterior portion of the cartilaginous nasal capsule to form a pouch-like cavity. The wall surrounding this cartilage is ossified in the later months of fetal development. Then, during the second and third years of life, the cartilage is resorbed, and the cavity becomes attached to the body of the sphenoid.

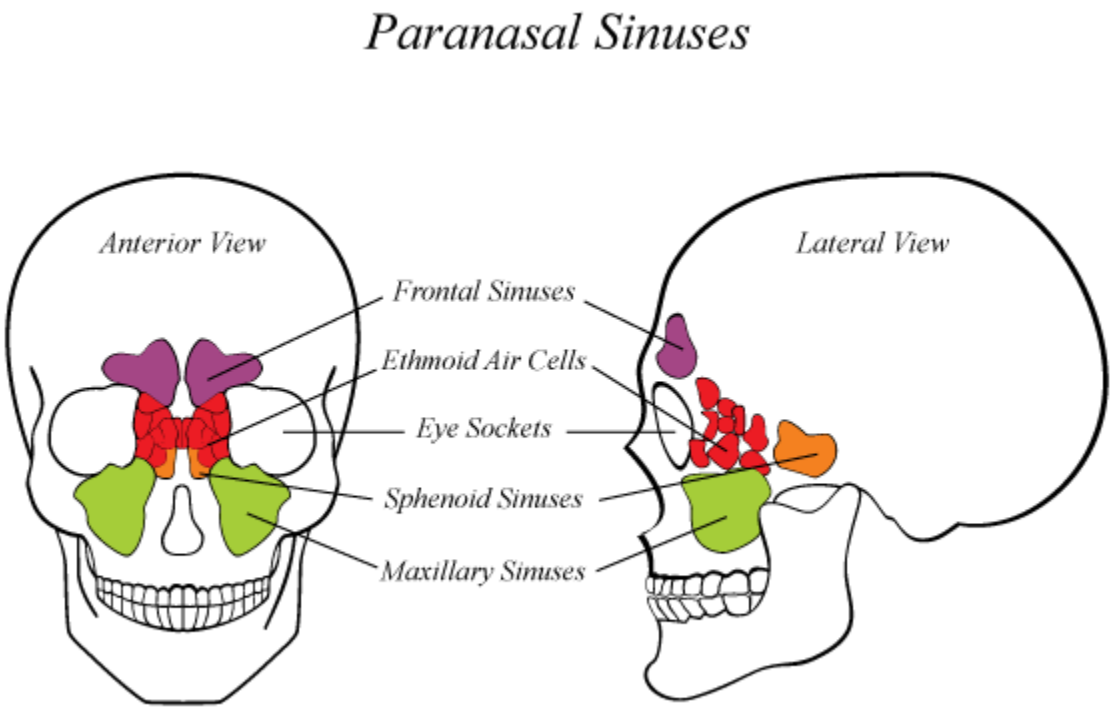
By the sixth or seventh year of life, pneumatization of the sphenoid sinus progresses. By twelve years of age, the pneumatization is complete with pneumatization of the anterior clinoids and pterygoid process.

2.3.The maxillary sinus

starts developing during the 10th week of intrauterine life. The ethmoid infundibulum invaginations towards the mesenchyme fuse during the 11th week of development, forming one oval cavity with smooth walls – the primordium of the maxillary sinus.The sinus ossification starts during the 16th week. The maxillary sinus shows a biphasic growth pattern at 3 and 7 to 18 years of age .[Brook, I. (2006)] 2.4 The ethmoid sinuses are comprised of three to four air cells at birth.

By the time an individual reaches adulthood, they consist of 1 to 15 aerated cells.

.[Brook, I. (2006)]



Paranasal Sinuses, medical professionals

The Para nasal sinuses are air-filled extensions of the nasal cavity. There are four paired sinuses – named according to the bone in which they are located – maxillary, frontal, sphenoid and ethmoid. Each sinus is lined by a ciliated pseudostratified epithelium, interspersed with mucus-secreting goblet cells.

The function of the paranasal sinuses is a topic of much debate. Various roles have been suggested:

- Lightening the weight of the head
- Supporting immune defence of the nasal cavity
- Humidifying inspired air
- Increasing resonance of the voice

The paranasal sinuses are formed during development by the nasal cavity eroding into the surrounding bones. All the sinuses therefore drain back into the nasal cavity – openings to the paranasal sinuses can be found on the roof and lateral nasal walls. [Zachary J. Cappello; Katrina Minutello; Arthur B. Dublin]

3.1. Frontal Sinuses

There are two frontal sinuses located within the frontal bone of the skull. They are the most superior of the paranasal sinuses, and are triangular in shape.

Drainage is via the frontonasal duct. It opens out at the hiatus semilunaris, within the middle meatus of the nasal cavity.

Sensation is supplied by the supraorbital nerve (a branch of the ophthalmic nerve), and arterial supply is via the anterior ethmoidal artery (a branch of the internal carotid).[Zachary J. Cappello; Katrina Minutello; Arthur B. Dublin]

3.2. Sphenoid Sinuses

The sphenoid sinuses are situated within the body of the sphenoid bone. They open out into the nasal cavity in an area supero-posterior to the superior cocha – known as the spheno-ethmoidal recess.

They are innervated by the posterior ethmoidal nerve (a branch of the ophthalmic nerve), and branches of the maxillary nerve. They recieve blood supply from pharyngeal branches of the maxillary arteries.[Zachary J. Cappello; Katrina Minutello; Arthur B. Dublin]

3.3. Ethmoidal Sinuses

There are three ethmoidal sinuses located within the ethmoid bone:

Anterior – Opens onto the hiatus semilunaris (middle meatus)

Middle – Opens onto the lateral wall of the middle meatus

Posterior – Opens onto the lateral wall of the superior meatus

They are innervated by the anterior and posterior ethmoidal branches of the nasociliary nerve and the maxillary nerve. The anterior and posterior ethmoidal arteries are responsible for arterial supply.[Zachary J. Cappello; Katrina Minutello; Arthur B. Dublin]

3.4. Maxillary Sinuses

The main function of the maxillary sinus is involved in the humidification and warming of inspired air as well as prevention of microorganism ingress through mucociliary action. In addition to this, the paranasal sinus contributes to voice resonance. A possible evolutionary function may also be as a ‘crumple zone’ during trauma, thus protecting the brain

In an adult, the maxillary sinus takes the form of a quadrangle pyramidal shape, with the base adjacent to the nasal cavity and the peak extending towards the zygomatic process, and a volume in the region of 15 cm3. The roof of the sinus

is formed of the orbital floor in the centre of which runs the infraorbital neurovascular bundle. The anterior wall of the maxillary sinus is the weakest of the walls, with the thinnest section superior to the canine resulting in the canine fossa. It is also perforated by the infraorbital nerve that supplies the maxillary sinus, along with the greater palatine nerve. The posterior wall of the sinus lies in front of and shelters the internal maxillary artery, sphenopalatine artery, Vidian canal and the greater palatine nerve. The inferior wall is the most varying in shape, with invaginations corresponding to the alveolar bone of the maxilla;

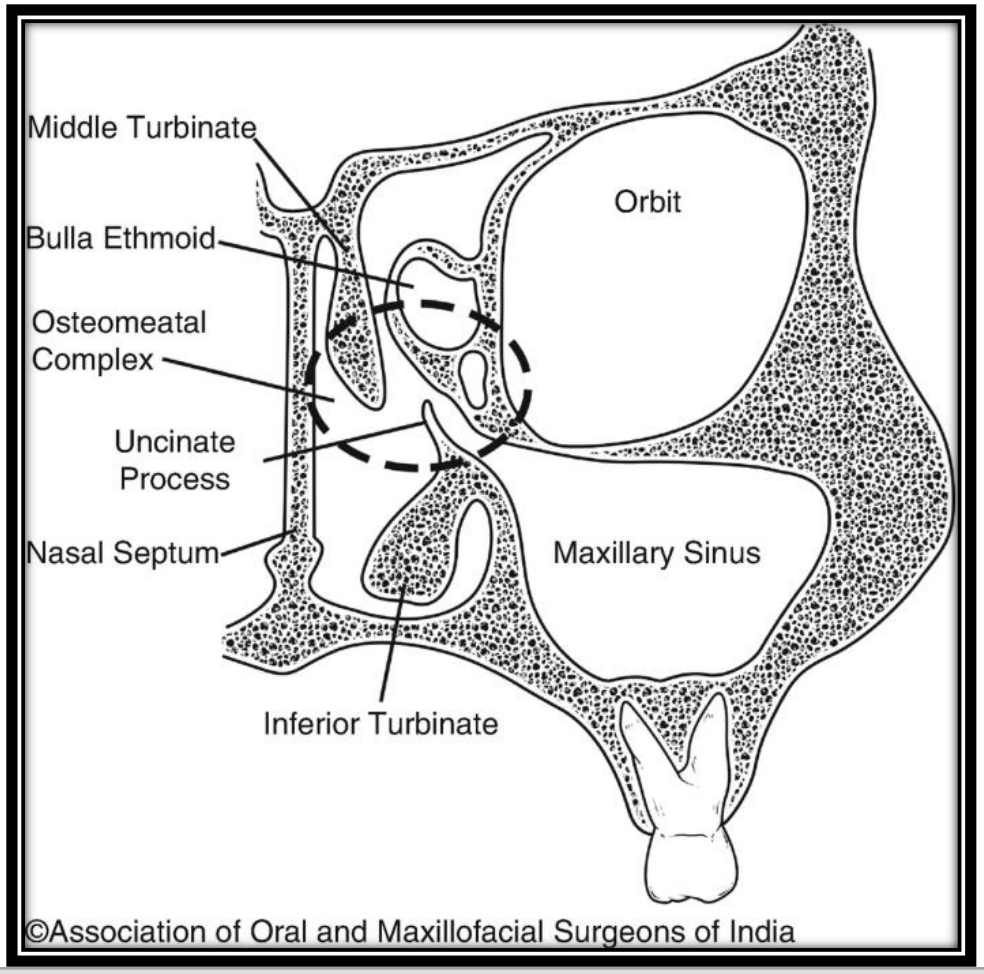
the anatomical root structures of maxillary molars and the hard palate. The bone separating the dental roots can be varying in its quantity; from complete absence to thicknesses of up to 12 mm . This close proximity is a contributing factor towards the likelihood of dental iatrogenic and inflammatory pathology presenting in the maxillary sinus. The medial wall that is parallel to the nasal cavity communicates with it through the natural sinus ostium at the postero-superior aspect of sinus. This ostium opens in to a triangular space of approximately 15 mm2 diameter formed by the uncinate process medially,

the lamina papyracea laterally and the ethmoidal bulla posteriorly before communicating with the nasal cavity through a semilunar hiatus in the middle meatus.

This is an area of common drainage from the maxillary, anterior ethmoidal and frontal sinuses. Some individuals may exhibit anterior/posterior

fontanelles; bony dehiscences inferior to this, covered with mucosa. These can act as accessory ostia, points of drainage when the main osteomeatal complex is blocked or there is a change in sinus pressure.

An osteomeatal complex (OMC) is an important functional unit and is also a key area for the pathogenesis of chronic rhinosinusitis. It consists of multiple bony structures, air spaces and ostia. The bony structures include the middle turbinate, uncinate process of the ethmoid and bulla of the ethmoid. Air spaces are formed by the frontal recess, infundibulum of the ethmoid and the middle meatus. Ostia consists of anterior ethmoid, maxillary and frontal sinuses. The classic OMC as mentioned above has been described as the anterior osteomeatal unit. The sphenoethmoidal recess and the superior meatus are referred to as the posterior meatal unit.[Zachary J. Cappello; Katrina Minutello; Arthur B. Dublin]

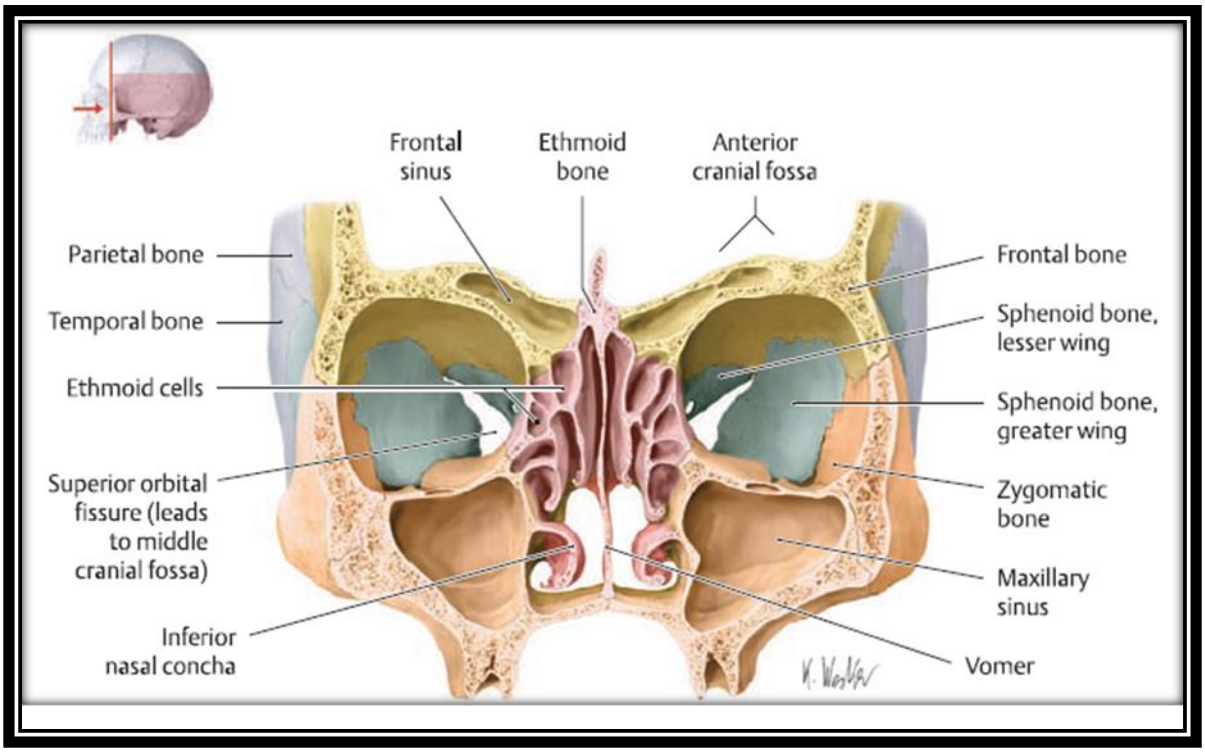


Schematic diagram showing a coronal cross section of the maxillary sinus and the osteomeatal complex

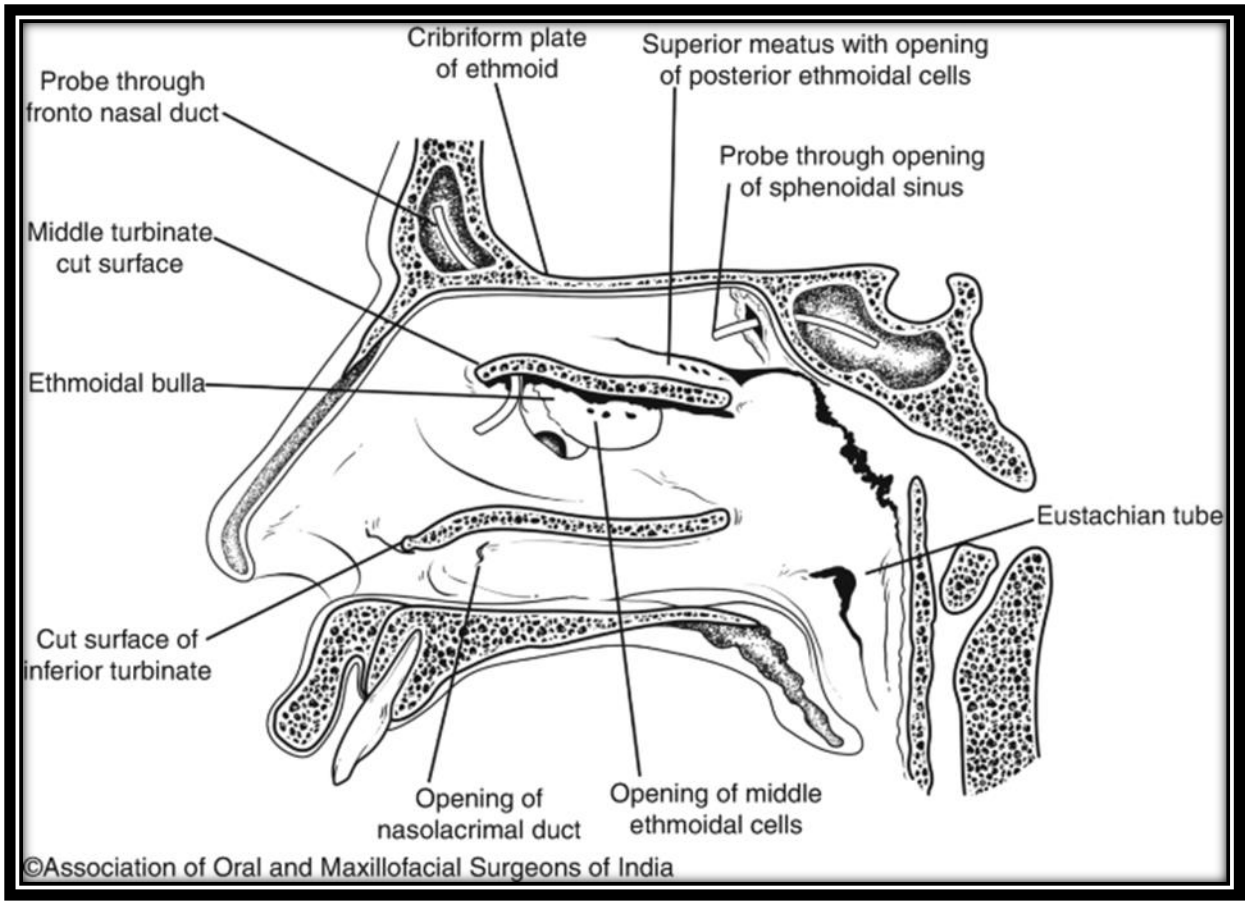
Maxillry sinus septa, present in approximately 28.4% of cases , are thin projections of cortical bone that divide the sinus into more than one compartment either in the transverse, sagittal or horizontal plane, usually in the region of the first or second molar.

Smaller air-filled compartments in the periphery of the maxillary sinus can include Haler cells and Concha bullosa. Haller cells are air cavities encompassed in the

ethmoidal capsule and are located below the inferomedial aspect of the orbital floor, and lateral to the ethmoidal cells. These can be present in a range of sizes as well as unilaterally or bilaterally. Concha bullosa is another variant air-filled cavity pneumatised in to the middle turbinate. These particular anatomical variations have the potential to influence the dimensions of the osteomeatal complex, increasing the likelihood of sinus disease.. .[Zachary J. Cappello; Katrina Minutello; Arthur B. Dublin]



The Maxillary Sinus Medical and Surgical Management , James A. Duncavage, Samuel S. Becker



Schematic diagram with a sagittal cross section of the nasal cavity and the respective openings in to it

3.5. Blood Supply and Lymphatics

The maxillary sinus is irrigated by branches of the maxillary artery: the infraorbital artery, the posterior superior alveolar artery (PSAA), and the posterior lateral nasal artery.[Joe Iwanaga]

The infraorbital artery travels through the infraorbital groove and canal and then through the infraorbital foramen. The posterior superior alveolar artery runs along the sinus' medial wall. The posterior lateral nasal artery can also be found within the medial wall of the maxillary sinus.

The maxillary sinus' innervation is provided by branches of the maxillary nerve: middle, anterior, and posterior superior alveolar nerves, and infraorbital nerve.[Joe Iwanaga]

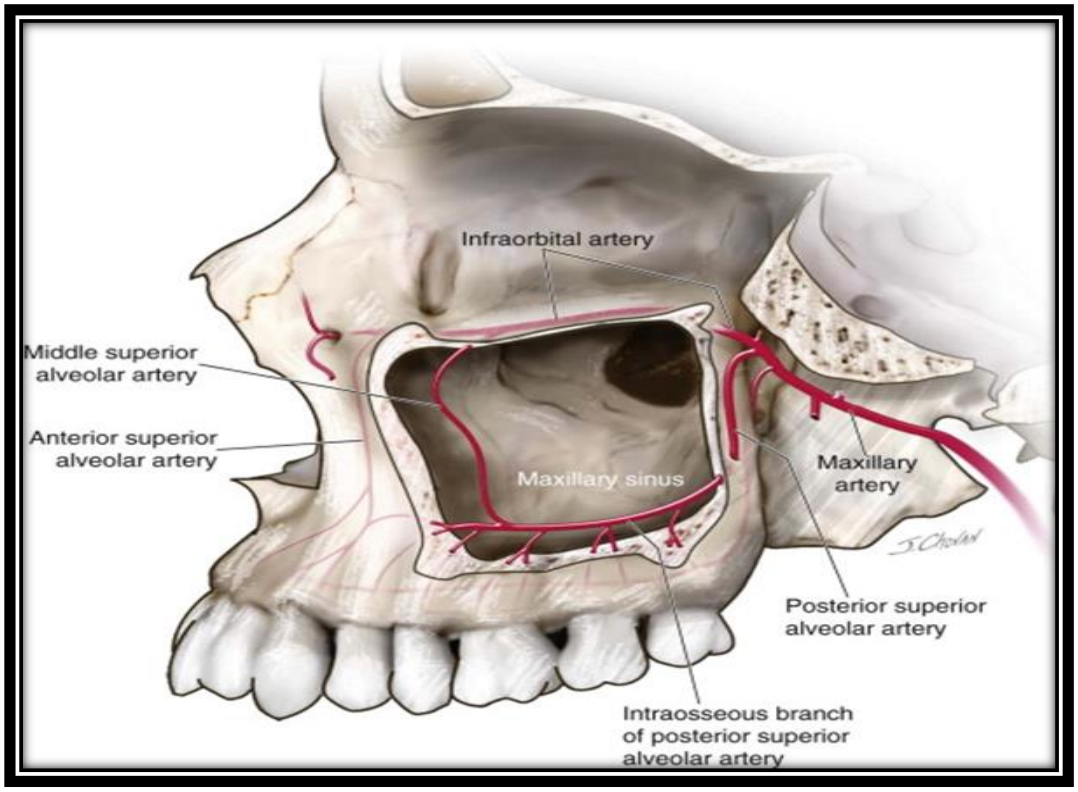
The frontal sinus vasculature consists of the supraorbital and supratrochlear arteries and ophthalmic and supraorbital veins.

The sphenopalatine artery supplies the sphenoid sinus, and venous drainage is via the maxillary vein.

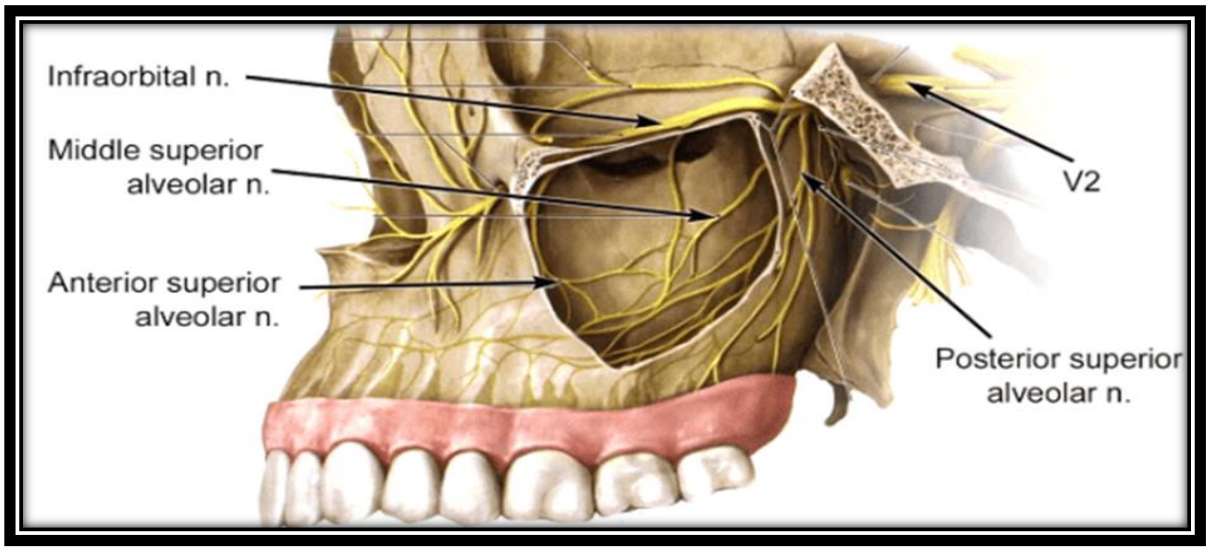
The ethmoid sinuses are supplied by the anterior and posterior ethmoid arteries, respectively. These arteries are branches of the ophthalmic artery, a branch of the internal carotid artery. Ethmoid sinus venous drainage is done by the maxillary and ethmoid veins.[Joe Iwanaga]

3.6.Nerves supply

The maxillary sinus' innervation is provided by branches of the maxillary nerve: middle, anterior, and posterior superior alveolar nerves, and infraorbital nerve. The sphenoid sinus' innervation is provided by the sphenopalatine nerve, which comprises parasympathetic fibers and CN V2. The frontal sinus is innervated by the supraorbital and supratrochlear nerves (CNV1). The anterior and posterior ethmoid nerves provide innervation to ethmoid sinuses.[Shiza Shafique; Joe M Das.]



Pocketdentistry/the maxillary sinus lift



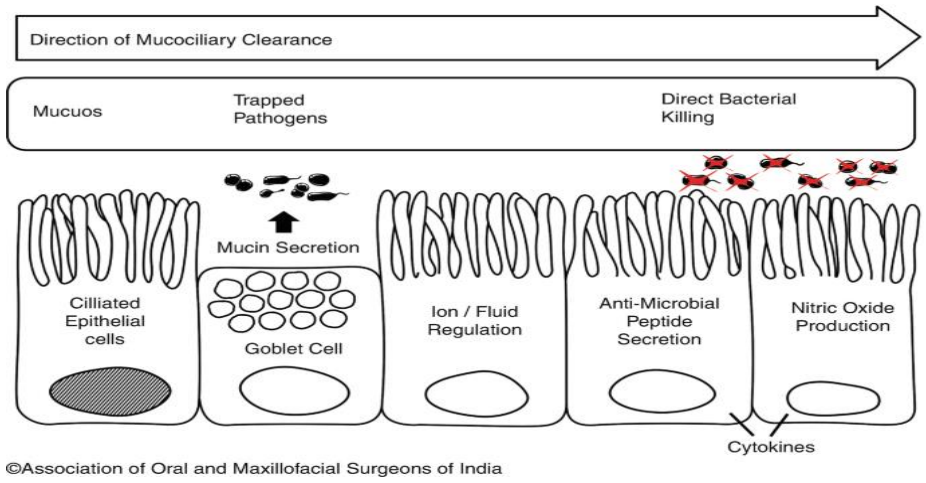
Anatomy qa/paranasal air sinuses anatomy

4.MAXILLARY SINUS PHYSIOLOGY

At a histological level, the maxillary sinus consists of ciliated columnar cells, basal cells and goblet cells and thus forming respiratory epithelium architecture. Unlike the rest of the respiratory pathway, the sinuses have fewer ciliated and goblet cells; friable epithelium and fewer seromucous cells, making them prone to microorganism ingress and related pathology.The clearance of secretions from the sinuses is through a combination of ciliary and mucous action. The mucous secreted by the goblet cells consists of 96% water, with the rest

consisting of glycoproteins, immunoglobulins, histamines, lactoferrin, prostaglandins and lysozymes. It functions to trap foreign body and defend against bacterial ingress. This is combined with the ciliary action that promotes a spiral action of movement of the mucous through active transport from the base of the sinus towards the natural ostium in the supero-posterior aspect of the medial sinus wall and thus working against the forces of gravity.[Antonio Cardesa]

Normal flora within the maxillary sinus is usually a combination of sterile aerobic and anaerobic organisms including bacteria organised in a complex biofilm within the sinus mucus layer. These usually include mainly aerobic B-hemolytic streptococci, staphylococci and haemophilus spp. The anaerobic organisms, that are fewer in quantity, include peptostreptococcus, fusobacterium sp and bacteroides.[Antonio Cardesa]



Schematic diagram of the secretary and clearance of the mucous via the mucociliary cells

5.SINUSITIS

Sinusitis is an inflammation, or swelling, of the tissue lining the sinuses. Sinuses are hollow spaces within the bones between your eyes, behind your cheekbones, and in your forehead. They make mucus, which keeps the inside of your nose moist. That, in turn, helps protect against dust, allergens, and pollutants.

Healthy sinuses are filled with air. But when they become blocked and filled with fluid, germs can grow and cause an infection.[Chemli H., Mnejja M.]

5.1.Sinusitis Pathophysiology

Due to the narrow size of the ostium opening, occlusion and related pathology of the maxillary sinus space are very likely possibilities. Obstruction of the sinus

ostium can either be primary to the sinusitis process or secondary inflammation originating from elsewhere in the sinus..[Chemli H., Mnejja M.]

With obstruction of the natural ostium, there is reduced oxygenation and gas exchange within the maxillary sinus, alongside reduced mucociliary action and mucous stasis. In the most common acute form of sinusitis, viral upper respiratory tract infections result in significant nasal congestion that results in maxillary sinus blockage and stasis. Anatomical differences such as large middle turbinates, deviated nasal septums or concha bullosa can increase the likelihood of ostium occlusion. Polyps, in particular those originating from the ethmoid, may also obstruct the maxillary sinus opening.[Chemli H., Mnejja M.]

Any form of obstruction and subsequent stasis in the maxillary sinus produce a favourable environment for the flourishing of an anaerobic environment, encouraging the formation of purulent secretions. In addition to this, changes in the sinus pressure, coupled with local mucosal inflammation, contribute to the symptoms of pain and pressure in the region . The initial lower sinus pressure is caused by the consumption of the finite oxygen within the blocked and confined maxillary sinus cavity. This is followed by a transient increase in pressure where there is a greater production of carbon dioxide and sinus secretion.[Chemli H., Mnejja M.]

Chronic rhinosinusitis has features of long-term inflammation, rather than primary infection, of the nasal passages and paranasal sinuses with an unknown underlying cause. It is likely to be part of a cycle involving inflammation, infection and

subsequent obstruction of the ostium . Without the presence of polyps, chronic sinusitis may be multi-factorial in nature, with one or several predisposing factors as outlined below.[Chemli H., Mnejja M.]

Nasal polyps are oedematous masses of the mucosal membrane found in the nasal passages and paranasal sinuses. Histologically, they show squamous epithelial proliferation, a thickened basement membrane, absence of neurosensory filaments and inflammatory cell infiltrate with high numbers of oesinophils . The pathogenesis in the formation of polyps and its contribution towards chronic rhinosinusitis is poorly understood. One in vivo study involving rabbits with stimulated maxillary sinusitis observed the formation of inflammatory-type polyps in subjects with purulent infection and granulation based polyps in both purulent and non-purulent infections. In both infective processes, epithelial damage to the mucosal lining appeared to be a significant factor in the initiation of polyp formation . Other evidence shows that high levels of interleukin 5, 13 and histamines in the polypoid tissue may also have a contributing role . The general consensus of studies shows a high level of inflammatory mediators in the initiation and presence of nasal polyps, suggesting chronic inflammation to be a key factor[Melen I, Lindahl L, Andreasson L]

5**.2.Classification of Sinusitis**

Sinusitis is defined as an inflammation of the paranasal sinus mucosal lining; however, it rarely presents in isolation and is usually coupled with the inflammation of the nasal mucosa, thus being termed as rhinosinusitis. The

cardinal features, of which two are required for a suggestive diagnosis of a rhinosinusitis, are outlined in the 2012 European position paper by the International Rhinology Society . The condition is broadly classified based upon the chronicity of the condition as well as whether there is presence of polyps. [Melen I, Lindahl L, Andreasson L]

5.2.1. Acute Rhinosinusitis

Acute rhinosinusitis (ARS) is defined as persistent sinusitis that resolves within a 12-week period. It is a common presentation within the populations globally, with prevalence rates between 6 and 15% [Jiam NT, Goldberg AN, Murr AH, Pletcher]

Acute sinusitis signs and symptoms often include:

Thick, yellow or greenish mucus from the nose (runny nose) or down the back of the throat (postnasal drainage)

Blocked or stuffy nose (congestion) causing difficulty breathing through your nose

Pain, tenderness, swelling and pressure around your eyes, cheeks, nose or forehead that worsens when bending over[Jiam NT, Goldberg AN, Murr AH, Pletcher]

Other signs and symptoms include:

- Ear pressure
- Headache
- Aching in your teeth

- Altered sense of smell
- Cough
- Bad breath
- Fatigue
- Fever

5.2.2. Chronic Rhinosinusitis

Chronic rhinosinusitis is defined by the persistence of sinusitis symptoms for greater than 12 weeks, with no resolution after initial sinusitis treatment. It is further subdivided into whether there is a clinical and radiographic presentation of nasal polyps. [Jiam NT, Goldberg AN, Murr AH, Pletcher]

Common signs and symptoms of chronic sinusitis include:

- Nasal inflammation
- Thick, discolored discharge from the nose (runny nose)
- Drainage down the back of the throat (postnasal drainage)
- Blocked or stuffy (congested) nose causing difficulty breathing through your nose
- Pain, tenderness and swelling around your eyes, cheeks, nose or forehead
- Reduced sense of smell and taste
- Other signs and symptoms can include:
- Ear pain
- Headache

- Aching in your upper jaw and teeth
- Cough or throat clearing
- Sore throat
- Bad breath
- Fatigue

Chronic sinusitis and acute sinusitis have similar signs and symptoms. But acute sinusitis is a temporary infection of the sinuses often associated with a cold. The signs and symptoms of chronic sinusitis last at least 12 weeks[Jiam NT, Goldberg AN, Murr AH, Pletcher]

5.2 .3 .Fungal Rhinosinusitis

This subtype of chronic rhinosinusitis involves the inflammation of the maxillary sinusitis that is attributed to a fungal pathogen and can be classified into acute fungal rhinosinusitis, fungus balls or fulminant invasive fungal rhinosinusitis. [Lechien J.R., Filleul O., Costa de Araujo P]

Acute fungal rhinosinusitis (AFRS), as described by Bent and Kuhn, is characterised by five properties :

1. Nasal polyps.

2. Type I hypersensitivity to fungi (skin test or serum IgE testing).

3. Sample positive for fungal staining.

4. Eosinophilic mucin that does not invade into sinus tissue.

5. Characteristic CT radiopaque sinus findings.

The predicted pathogenesis of AFRS is believed to be an allergic, immediate hypersensitivity reaction to an inhaled fungal organism resulting in a chronic inflammatory response in a predisposed individual, usually with asthma. The most common isolated fungal species include Bipolaris, Curvularia, Aspergillus, and Drechslera species. [Lechien J.R., Filleul O., Costa de Araujo P]

Fungal balls are non-invasive, dense collections of fungal debris within the maxillary sinus. Found in mostly immunocompromised and elderly individuals, they are formed commonly of aspergillus, in response to prolonged exposure to the fungi through inhalation of airborne spores or oral antral communication. [Lechien J.R., Filleul O., Costa de Araujo P]

Symptoms of fungal sinusitis include:

- ❖ Decreased sense of smell or a bad smell in the nose.
- ❖ Fever
- ❖ Inflammation (swelling) in the nose and sinuses.

- ❖ Nasal congestion and runny nose.
- ❖ Pain, tenderness and pressure in the sinus area. It may hurt when you touch your cheeks or forehead.
- ❖ Sinus headache

People with weakened immune systems have a higher risk of serious symptoms of fungal sinusitis. These include:

Behavioral changes and neurological problems (trouble with thinking and reasoning). [Lechien J.R., Filleul O., Costa de Araujo P]

Changes in skin color (the skin may turn very pale or black).

- Facial numbness.
- Proptosis (eyeballs that protrude, or stick out, from the eye sockets).
- Severe swelling in the cheeks or eyes.
- Vision changes, vision loss and blindness.

6.odontogenic maxillary sinusitis

6.1.Definition and etiology of OMS

Odontogenic sinusitis is most commonly the result of iatrogenic injury of the mucoperiosteum, or Schneiderian membrane, of the maxillary sinus. Dental procedures such as dental extractions, maxillary dental implant placement, sinus

augmentation grafts ("sinus lift"), misplaced foreign bodies as well as orthognathic and cleft surgery procedures have all been associated with odontogenic sinusitis. [Lee K.C., Lee S.J]

Other potential etiologies include periodontal and periapical disease. Endodontic infections are typically the result of extension of dental caries into the dental pulp resulting in pulpitis and apical infection. Alternatively, chronic periodontitis may occur in the setting of chronic infection of a tooth socket. The resultant inflammation and/or disruption of the Schneiderian membrane leads to mucosal inflammation and altered mucociliary function within the maxillary sinus. Impaired mucociliary function results in altered mucus transport, impaired mucosal defenses, blockage of sinus ostia and resultant bacterial infection and inflammation. Other less common etiologies of odontogenic sinusitis include maxillary bone trauma, odontogenic cysts, neoplasms or other inflammatory processes. [Lee K.C., Lee S.J]

Improvement in oral hygiene through various public health campaigns and enhanced national awareness have reduced the frequency of periodontal disease; however, recent increases in the rates of invasive dental surgery, including dental implant treatment, have been associated with rising rates of iatrogenic causes for sinusitis., [Lee K.C., Lee S.J]

In addition, rates of surgical intervention to address iatrogenic cases of odontogenic sinusitis may be as high as 80%.Damage to the Schneiderian membrane of the sinus floor can occur with dental implants or foreign bodies, and

this finding has also been associated with the need for surgical intervention. [Lee K.C., Lee S.J]

A variety of odontogenic diseases involve the maxillary sinus, from the lining of the sinus to the adjacent paranasal sinuses and dental tissues, or from the adjacent bone with expansion into the sinus . Tooth extraction-related OMS is the most common cause , alongside other dento-alveolar lesions including dentigerous cysts ,radicular lesions , dental caries , impacted teeth, and root infections of external resorbed molars .The molar region has a frequency of involvement of 47.68%, followed by the first molar (22.51%), the third molar (17.21%), and the second molar (3.97%). The premolar region is involved in 5.96%, followed by the canine in 0.66%[Lee K.C., Lee S.J]

Odontogenic infections begin with the attachment of bacteria to the outer surface of teeth, eventually breaking down the outer enamel and inner dentin and making its way into the vital pulp. Once the infection enters the pulp, it leads to the necrosis and pus formation. The body is unable to eliminate the source of infection because the necrotic pulp is protected within the tooth roots. Bacteria colonize the apical portion of the root and their toxins can damage tissues causing a periapical infection. An acute, rapidly-spreading infection is much more destructive than slowly-developing inflammation, affecting the adjacent maxillary sinus in a short time. Bacteria from the lesion can spread to the adjacent tissues and activate a reaction from the Schneiderian membrane epithelium which seems to be

hypertrophic and inflamed. If the endodontic treatment fails and microorganisms resist and continue growing, the formation of secondary periapical lesion will be noticed. [Lee K.C., Lee S.J]

Extrusion of dental materials used in root canal therapy into the maxillary sinus has also a high risk of producing OMS. According to a meta-analysis based on articles published between 1986 and 2007, iatrogenic causes (55.9%) for OMS included extrusion of endodontic obturation materials into the maxillary sinus (22.7%), such as amalgam after apicoectomies (5.3%). Other endodontic microtools and root filling materials such as gutta-percha cones can also penetrate the apical foramen protruding into the maxillary sinus floor and resulting in OMC. [Lee K.C., Lee S.J]

Less commonly, dentigerous cysts may be associated with a displaced maxillary molar or an ectopic impacted third molar in the maxillary sinus presenting as OMS. [Lee K.C., Lee S.J]

Dentigerous cysts are odontogenic cysts that can occur in the maxillary bone close to the sinus and consist of a fluid-filled sac with a thick surrounding; that cyst can cause thinning of the bone under mass effect and, if untreated, it can expand into the maxillary sinus. [Lee K.C., Lee S.J]

The dental implant is increasingly used nowadays for partial or complete edentulous patients; moreover, before dental implantation, in order to increase alveolar bone height, an osteotomy of the lateral maxillary sinus wall is

performed following by graft placement, a procedure called sinus lift. However, during or after these procedures local infections (peri-implantitis) may cause OMS, which may lead to implant failure or severe complications, such as orbital cellulitis, extradural and subdural infections, and osteomyelitis. [Chemli H., Mnejja M., Dhouib M]

Oroantral communication (OAC) and epithelialized formation of OAF are common complications during dental surgery which can lead to sinus infection. The OAC can occur with frequencies between 0.31% and 4.7% after the extraction of upper teeth; a displacement of dental root into the sinus may also occur following root fracture. During tooth extraction, significant forces are exerted on the alveolar bone, especially in the presence of impacted tooth or widely divergent roots, which makes this procedure more difficult4; when a periapical cyst, granuloma or periapical infection is present or during apicoectomy, the surrounding bone becomes eroded and the bone separating maxillary sinus from the oral cavity thinner, resulting in exposure of the sinus. [Chemli H., Mnejja M., Dhouib M]

6.2.Bacteriology

Odontogenic sinusitis is a polymicrobial infection in which bacteria from both oral cavity and upper respiratory system are involved, in predominance anaerobic species. Brook in 48 patients suffering from OMS, showed that gram-negative bacilli, such as Peptostreptococcus spp. and Fusobacterium spp. were the main anaerobes bacteria, which predominated over aerobes in both acute and chronic

OMS. The same author compared the microbiology of aspirates from 5 periapical abscesses of the maxilla and their corresponding maxillary sinusitis (through the inferior meatal antrostomy); they found concordance between periapical abscess and the maxillary sinus flora (mainly anaerobes) in all the patients, underlying the direct extension of such microorganisms from the maxillary molar teeth to the proximal floor of the maxillary sinus.[George Psillas]

Puglisi et al. demonstrated that mixed aerobic–anaerobic infections were found in 75% of 12 patients with chronic OMS (main aerobes: Staphylococcus aureus, Streptococcus pneumoniae, main anaerobes: Prevotella spp., Peptostreptococcus spp.). Bacteria strongly associated with chronic rhinosinusitis like Haemophilus influenza and Moraxella catarrhalis were not found in OMS. Tashieri et al. showed that apical lesions are mainly caused by Actinomyces spp., an anaerobic bacteria, which avoid the phagocytosis, and is related to the formation of biofilms on root surfaces or the presence of other endoantral foreign bodies. Finally, it has been concluded that anaerobic bacteriological flora is the most common cause of chronic OMS, while the main flora is mixed in patients with acute OMS.[George Psillas]

It has been reported that dental roots following endodontic treatment, such as zinc oxide-eugenol, in close proximity to maxillary sinus may result in positive cultures for Aspergillus. In Zirk et al. study that included 121 patients suffering from OMS who underwent surgery, aspergillus was found in 5 patients in

the sinus, and in 4 cases of aspergillosis a foreign body was detected in the sinus; in addition, aspergillosis was detected once after tooth extractions.[George Psillas]

6.3.Symptoms

main symptoms related to OMS are facial pain or pressure, nasal congestion, purulent rhinorrhea that may be unilateral, cacosmia, and postnasal drip. Hoskison et al. reported that 21 (81%) and 19 (73%) out of 26 patients with OMS complained of rhinorrhea and cacosmia, respectively. In a study that included 27 patients with OMS, rhinorrhea was found in 66.7% of cases, cheek pain in 33.3% and cacosmia in 25.9%.[George Psillas]

However, these symptoms do not distinguish OMS from other causes of sinusitis, as some patients experience sinusitis-like symptoms, such as dental pain and nasal congestion, whereas others present with minimal sinusitis symptoms and dental pain, because the osteomeatal complex is not obstructed and allows drainage and relief of pressure. Longhini and Ferguson reported that dentists did not diagnose dental infection causing OMS in 6 (85%) out of 7 cases; similarly, 56 (55%) out of 99 of OMS cases were missed on routine dental examination including dental X-ray.[George Psillas]

Less than half of patients presenting with OMS report a recent dental procedure; this is because, for example, OMS can appear within 1 year after augmentative dental surgery following graft infection. OMS may also occur after a latency

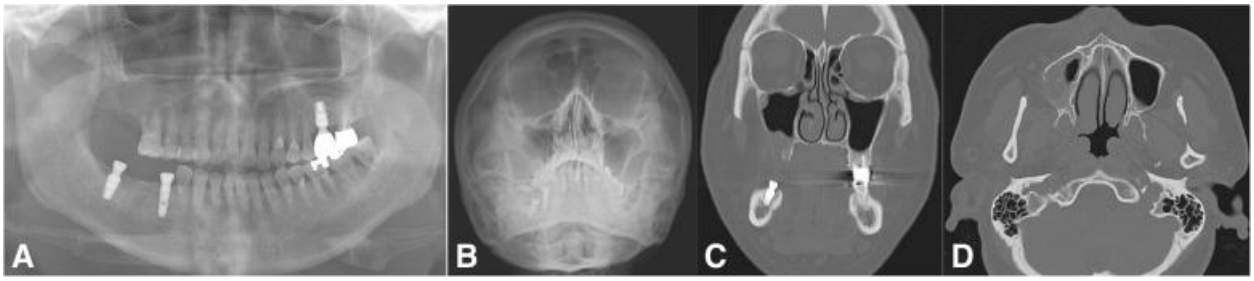
period of almost 4 years as a late complication of dental implantology due to progressive peri-implantitis.[George Psillas]

6.4.Diagnosis of OMS

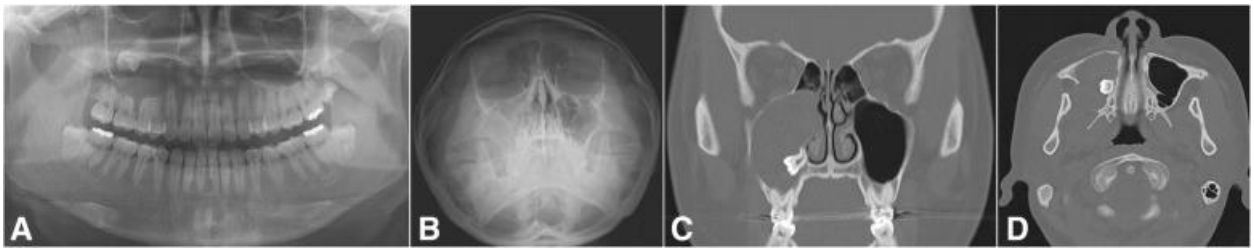
The most frequent clinical features of OMS can be divided into dental and sinonasal symptoms. Dental symptoms including involved tooth pain and hypersensitivity are not easily identified as odontogenic causes, but infrequent dental discomfort may occur after OMU patency preservation with continuous progression of maxillary sinus symptoms. Representative sinonasal symptoms are unilateral cheek pain with nasal obstruction, purulent rhinorrhea, foul odor, foul taste, headaches, anterior maxillary tenderness, and postnasal drip. These symptoms cannot be distinguished from other causes of rhinitis, nor can any typical symptom be considered predominant in OMS . .[George Psillas]

Unilateral nasal obstruction with facial pain and pressure is also a common symptom in OMS, and foul odor with rotten taste combined with tooth pain appears to clinically differentiate CMS and OMS . The most common dental causes are periapical abscess, periodontal disease, post dental extraction, OAF, and undetected foreign bodies in the sinus. OMS can also develop due to maxillary osteomyelitis, radicular cysts, mechanical injury of the sinus mucosa during root canal treatment, overfilling of root canals with endodontic material, incorrectly

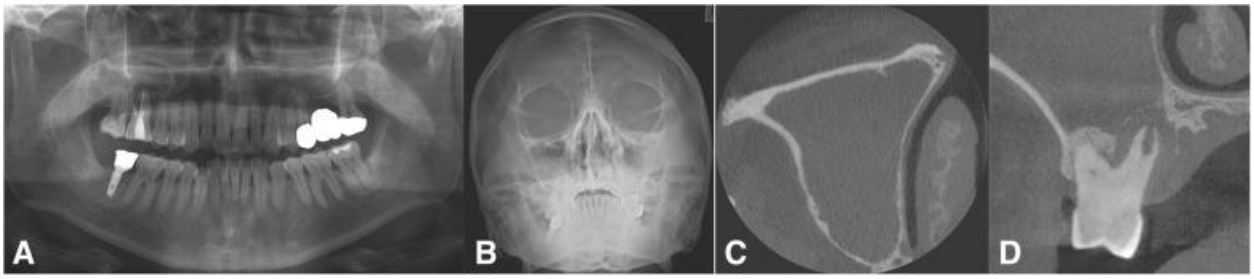
positioned dental implants, and improperly performed sinus augmentation .[George Psillas]



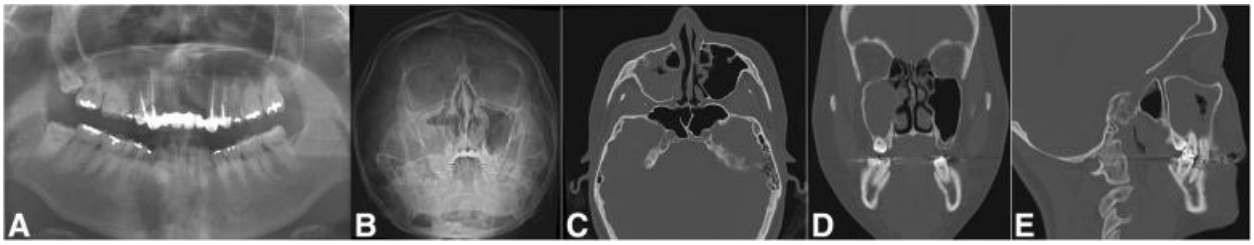
Chronic oronasal fistula after second molar extraction with several points of alveolar bony resorption indicates odontogenic maxillary sinusitis. Preoperative panoramic (**a**), Water's (**b**), coronal CT scan (**c**), and axial CT scan (**d**) views



A case of odontogenic maxillary sinusitis originating from a tooth bearing a huge cyst in the right maxillary sinus. Preoperative panoramic view (**a**), Water's view (**b**), coronal CT scan view showing a bony expansible cystic mass with ostium obstruction (**c**), and axial CT scan view showing the posterior expansional mass (**d**)



A representative case of odontogenic maxillary sinusitis originating from an apical lesion in the right upper second molar. Preoperative panoramic (**a**), Water's (**b**), axial cone-beam CT scan (**c**), and coronal cone-beam CT scan (**d**) views



Odontogenic maxillary sinusitis originating from both an impacted third molar and a root infection of an external resorbed first molar in the right maxillary sinus. Preoperative panoramic view (**a**), Water's view (**b**), and axial CT scan view showing an air-bubble and including a sinus mass (**c**). A coronal CT scan view showing the direct involvement of the right first molar (**d**) and a sagittal CT scan view showing direct involvement with three molars (**e**)

Pan-sinusitis on both paranasal sinuses originating from the root infection of the right first molar. Preoperative panoramic view (**a**), Water's view (**b**), axial CT scan view showing sinusitis of both maxillary sinuses (**c**), coronal CT scan view showing whole sinusitis including both ethmoidal and frontal sinuses (**d**), and sagittal CT scan view showing involvement of the root pathologic lesion of the right first molar (**e**)

6.5.Pathogenesis of OMS

Excluding close anatomical relationships, which can be thought of as facilitating inflammatory spread from the maxillary molars and premolars to the inferior maxillary sinus wall, many other conditions can contribute to the pathogenesis of OMS. Endo-antral syndrome was presented as a spreading pulpal disease by Selden , characterized by pulpal disease, periapical radiolucency or lamina dura loss on radiographs, faintly radiopaque mass bulging into the sinus wall, and variable radiopacities on the inferior sinus wall. Rapid spreading of dental infections may also lead to infraorbital cellulitis, transient blindness, and even life-threatening cavernous sinus thrombosis . [Soung Min Kim]

The prevalence of OMS with secondary periapical lesions is 16–65% , and its management is more complicated than cases with only primary lesions .

Endodontic lesions spreading into the sinus are characterized by epithelial cells surrounded by connective inflammatory tissues . Endodontic lesions could become evoluted over time during the acute or invasive phase, as well as the chronic phase. The acute phase is much more invasive and can cause the spread of bacteria directly into the sinus cavity and SM, causing hypertrophic reactions. Furthermore, if endodontic treatment does not eliminate the causative microorganisms, these hypertrophic reactions can lead to recurrent periodontitis or secondary periapical lesions . [Soung Min Kim]

Other causes of OMS are SM mucosal edema with inflammatory cell infiltrates, odontogenic or mucous retention cystic formation, hypertrophic scarring or granulation, hyalinization, and necrotic odontogenic infections . Apical lesions may lead to inflammation and thickening of the SM adjacent to the involved tooth roots and consequently to periapical osteitis with sinus mucosal hyperplasia [Soung Min Kim]

6.6.Management of odontogenic maxillary sinusitis

Treatment for Odontogenic Maxillary Sinusitis Initial Treatment: Antibiotic therapy (Penicillin, clindamycin, and metronidazole are adequate drugs of initial choice), For moderate to severe cases, an increase drug dose and intravenous administration of antibiotics are especially recommended. Drainage to reduce pain intensity, prevents disease progression, and encourages resolution.[Hanie Ahmadi]

General management of odontogenic maxillary sinusitis

I. 8 Steps II. By Surgical Means

8 Steps in Managing odontogenic infections

1. Determine the severity of infection.

2. Evaluate host defenses.

3. Decide on the setting of care.

4. Treat surgically.

5. Support medically.

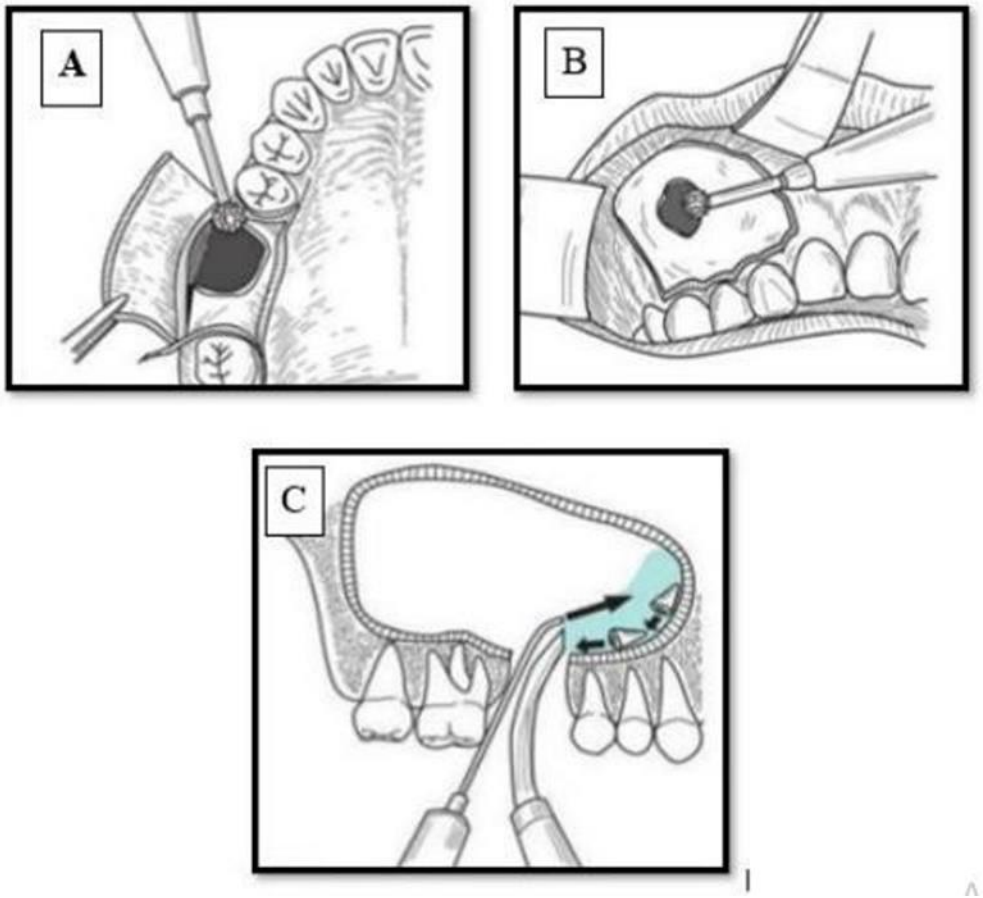
6. Choose and prescribe antibiotic therapy.

7. Administer the antibiotic properly.

8. Evaluate the patient frequently [Phil Jevon]

By Surgical Means

Caldwell-Luc Procedure - Involves complete removal of the antral lining and creating of a new opening for more dependent drainage into the nose by transoral approach. A foreign body displaced into the antral cavity can be retrieved with small forceps and with the use of suction through the expanded extraction socket a bone opening in the canine fossa [Phil Jevon]



A: If the dental root or foreign body is displaced from extraction socket, the socket may be enlarged buccally after elevation of mucoperiosteal flap to expose the maxilla above the socket. [Phil Jevon]

B: After the flap is reflected, a new small oroantral opening is created in the bone, 1cm above the root apices of the first premolar

C: Saline solution is injected into the antral cavity to flood sinus through the expanded socket or the opening and then a suction tube is inserted. [https://www.researchgate.net/figure/Caldwell-Luc-Procedure-A-B-C_fig1_358996143]

The foreign body is likely to be sucked out together with saline solution or moved close to the opening for easy retrieval. After removal of foreign body and irrigation of sinus using saline, the wound is primarily closed. Use of short-term prophylactic antibiotic is recommended. [Phil Jevon]

The inflamed sinus mucosa can be removed using Endoscopic sinus surgery (ESS). This procedure is performed under general anesthesia for treatment of chronic, acute, fungal, bacterial sinusitis as well for others various sinus pathologies. An endoscope is passed through the nose and provides the view of the infected sinus mucosa, osteomeatal complex condition, polyps and etc. The natural ostium is widened surgically, and only infected sinus mucosa is removed, leaving the basement membrane intact. Thus, natural sinus mucosa is preserved and mucocilliary clearance is not disturbed. Due to the proximal contact to anatomical structure such anorbital nerve, internal carotid and eyes, this procedure requires high experience and precision[Phil Jevon]

6.6.Prevention of anticipated complications

OAF is the most common complication related to OMS. The main cause of OAF is the extraction of a maxillary posterior tooth, which accounts for more than

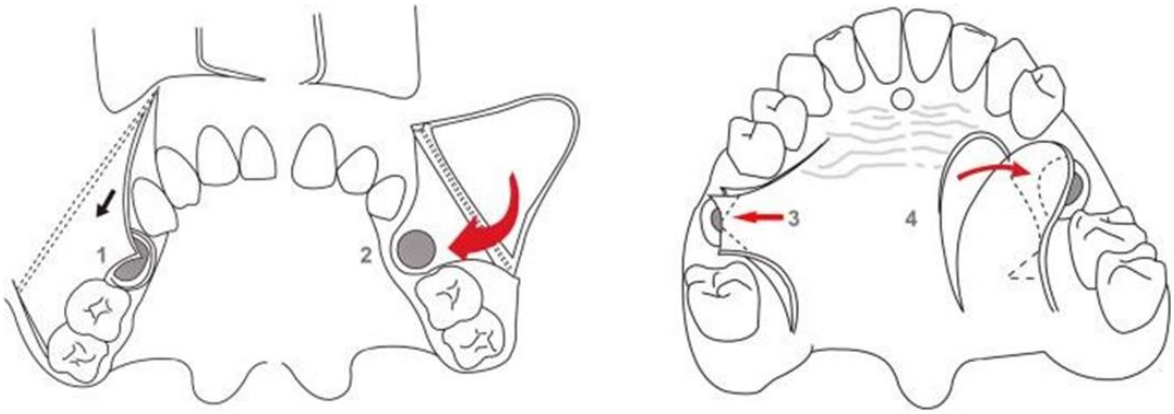
80% of all OAF cases . This form of OAF is also referred to as or nasal fistula or oroantral communication, in which CRS may consequently occur via oral mucosal penetration between the posterior maxillary alveolus and the infero-lateral wall of the maxillary sinus. The main symptom of chronic non-healing OAF is purulent discharge through the fistula, especially when the patient drinks or blows through the nose from the OAF into the oral cavity or vice versa. [Pulkit Khandelwal]

Regarding closure of the OAF, considerations of fistula size and depth are important for successful management. OAF can be self-covered with oral epithelium and granulation tissue or polyposis of the sinus mucosal membrane, [Pulkit Khandelwal]

but in cases of unsuccessful self-closure, hyperplasia of the sinus mucosal membrane can cause the formation of a very severe permanent fistula canal between the oral cavity and nose. Excluding the avoidance of OAF formation, the first solution for OAF would be CLP or FESS. The primary closure of OAF is determined according to defect size and health of the oral mucosa. Direct closure or extended surgical flaps, including buccal advancement, palatal island or pedicled flaps, may be considered for OAF management . [Pulkit Khandelwal]

Additionally, the use of an absorbable barrier membrane, gold foils, or buccal fat pad closure could also be considered for severe OAF cases . In every OAF case, maintaining a disease-free maxillary sinus

membrane without infective microorganisms is also important for the functional recovery of the maxillary sinus . [Pulkit Khandelwal]



Schematic drawings of an oroantral fistula closure in the oral cavity. Direct closure (1), buccal flap (2), palatal releasing flap (3), and palatal rotational pedicled flap (4) [https://jkamprs.springeropen.com/articles/10.1186/s40902-019-0196-2/figures/11]

7. References

- 1. Brook, I. (2006). Sinusitis of odontogenic origin. Otolaryngology-Head and Neck Surgery, 135(3)
- https://pubmed.ncbi.nlm.nih.gov/16949963
- 2. Odontogenic maxillary sinusitis: A comprehensive review, J Dent Sci.
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7770314/
- 3.Mehra P., Jeong D. Maxillary sinusitis of odontogenic origin. Curr Allergy Asthma Rep. 2009

- https://pubmed.ncbi.nlm.nih.gov/19348725
- 4. Lechien J.R., Filleul O., Costa de Araujo P., Hsieh J.W., Chantrain G., Saussez S. Chronic maxillary rhinosinusitis of dental origin: a systematic review of 674 patient cases. Int J Otolaryngol
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4000986/
- 5. Akhlaghi F., Esmaeelinejad M., Safai P. Etiologies and treatments of odontogenic maxillary sinusitis: a systematic review. Iran Red Crescent Med J. 2015;17
- https://pubmed.ncbi.nlm.nih.gov/26756016
- 6. Lee K.C., Lee S.J. Clinical features and treatments of odontogenic sinusitis. Yonsei Med J. 2010;
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2995970/
- 7. . Felisati G., Chiapasco M., Lozza P., Saibene A.M., Pipolo C., Zaniboni M. Sinonasal complications resulting from dental treatment: outcome-oriented proposal of classification and surgical protocol. Am J Rhinol Allergy. 2013;
- https://pubmed.ncbi.nlm.nih.gov/23883801
- 8.Chemli H., Mnejja M., Dhouib M., Karray F., Ghorbel A., Abdelmoula M. Sinusites maxillaires d'origine dentaire: traitement chirurgical. Rev Stomatol Chir Maxillofac. 2012;
- https://pubmed.ncbi.nlm.nih.gov/22317989
- 9. . Fadda G.L., Berrone M., Crosetti E., Succo G. Monolateral sinonasal complications of dental disease or treatment: when does endoscopic endonasal surgery require an intraoral approach? Acta Otorhinolaryngol Ital. 2016

- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5066466/
- 10. Abrahams J.J., Glassberg R.M. Dental disease: a frequently unrecognized cause of maxillary sinus abnormalities? Am J Roentgenol. 1996
- https://pubmed.ncbi.nlm.nih.gov/8615273
- 11. Taschieri S., Torretta S., Corbella S., Fabbro M.D., Francetti L., Lolato A. Pathophysiology of sinusitis of odontogenic origin. J Investig Clin Dent. 2017
- https://pubmed.ncbi.nlm.nih.gov/26662929
- 12. . Liston P.N., Walters R.F. Foreign bodies in the maxillary antrum: a case report. Aust Dent J. 2002
- https://pubmed.ncbi.nlm.nih.gov/12587772
- 13. Melen I, Lindahl L, Andreasson L, Rundcrantz H. Chronic maxillary sinusitis: Definition, diagnosis and relation to dental infections and nasal polyposis. Acta otolaryngol (Stockh) 1986
- https://pubmed.ncbi.nlm.nih.gov/3705956
- 14. Puglisi S, Privitera S, Maiolino L, et al. Bacteriological findings and antimicrobial resistance in odontogenic and non-odontogenic chronic maxillary sinusitis. J Medical Microbiology 2011
- https://pubmed.ncbi.nlm.nih.gov/21498651
- 15. . Jiam NT, Goldberg AN, Murr AH, Pletcher SD. Surgical treatment of chronic rhinosinusitis after sinus lift. Am J Rhinol Allergy 2017
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5498319/